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ZERO SPEED INDICATING DEVICES AND PROCESSES FOR TESTING SAME

THE FIELD OF THE INVENTION

This application is a Divisional Application carvėd out of currently pending application Serial No. 09/165,717 filed October 2, 1998 and entitled: Zero Speed Indicating Devices and Process for Testing Same.

This invention relates to the testing for faulty, therefore dangerous, performance of various types of zero speed indicators that are used to prevent a machine guard from being opened until the machine has come to a complete stop or has slowed sufficiently to prevent injury to anyone intending to access or work on the machine in the guarded space. The testing methods, devices, processes and decisions on test outcomes, are constructed and arranged so that the indicators can be tested while the machine is running, preventing unnecessary production interruptions and machine shutdowns, as well as take advantage of scheduled and unscheduled machine shutdowns to perform the tests. By performing these tests the hazardous opening of a guard due to a faulty zero speed indication can thus be anticipated and prevented.

For additional safety, machine guard protective systems will sometimes utilize motion interference or blocking devices which are inserted in the motion path of a component of the stopped machine so that machine motion cannot take place while the guard is open. The present invention further relates to the testing of the insertion of motion interference or blocking devices in conjunction with zero speed indicators, both of which must perform correctly in order to permit the unlocking and opening of the guard.

BACKGROUND OF THE INVENTION

Barrier guards, shields, covers, screens and the like are among the oldest known safeguards for protecting personnel from the hazards of moving machinery. Their effectiveness derives from three properties: they prevent entry of the body into the zone of operation, they retain expelled missiles, and they define the safe from the unsafe portions of the machine. The

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caused by machine stop initiations; 3) a subroutine in which there is insertion of a motion interference device at the completion of the speed run down brought about by initiating stopping of the machine and 4) a subroutine for checking the fulfillment of the necessary conditions for unlatching a guard closure.

BRIEF DESCRIPTION OF DRAWINGS AND FLOW DIAGRAMS

The following drawings and flow diagrams show the applications, methods, concepts, processes and execution of the present novel inventions.

Fig. 1 is a schematic view of a machine control arrangement including a safety control arrangement and a zero speed indicator testing system;

Fig. 2A Shows a zero speed indicator assembly connected to the driving mechanism of a press, where the indicator assembly is to be tested in situ during running of the machine without its shutdown, by temporarily detaching the indicator assembly in situ from the driving mechanism.

Fig. 2B shows the zero speed indicator assembly of Fig. 2A temporarily detached in situ from the press driving mechanism, in which position the indicator assembly can be tested while the machine can continue to operate;

Fig. 3 shows a zero speed indicator connected by a clutch/brake timing belt unit to the driving shaft of a continuously running circular saw system, wherein by temporarily declutching the indicator timing belt drive shaft from the saw drive shaft and applying the brake to the timing belt drive shaft the indicator can be tested in situ during running of the saw without its shutdown;

Figs. 4A and 4B illustrate a flow diagram of a subroutine for in situ testing zero speed indicators while the machine is running.

Fig. 5 shows a zero speed indicator connected to the driving mechanism of a press, requiring intermittent type of operations wherein the indicator without uncoupling can be tested in situ each time the ram crank shaft is braked to a stop required by an intermittent task of the press operation as well as during scheduled and unscheduled stop initiations of the press power drive itself.

Figs. 6A and 6B illustrate a flow diagram of a subroutine for in situ testing zero speed indicators during the speed run down phases caused by machine stop initiations;

Fig. 7 shows the system of Fig. 5 equipped with a separate clutch/brake unit for the zero speed indicator, whereby it illustrates that combining methods and systems of this invention enables the testing of zero speed indicators in situ both while the machine is running and during machine stop initiations using a single test system;

Fig. 8 discloses a system wherein when the guarded machine members reach zero speed a motion interference device is inserted to insure that it is absolutely safe to open the guard closure;

Fig. 9 is a flow diagram of a subroutine for insertion of a motion interference device at speed rundown completion caused by machine stop initiations;

Fig. 10 is a flow diagram of a subroutine for checking the fulfillment of necessary conditions for unlatching a guard;

Figs. 11 A-1, 11A-2, 11B-1 and 11B-2 are an example of a main routine for testing safeguarding devices and systems for guard closures that utilizes the subroutines of Figs. 4A and 4B, 6A and 6B, 9 and 10

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The novel inventions disclosed herein relate to safety guard systems that employ zero speed indicators that are utilized to indicate when the speed of the machine components they are

guarding have come to the stop required for the safe access to the guarded space, thereby either permitting or actually effecting the unlocking of the guard closures preventing access to such machine components. The novel invention also relates to the interaction of the zero speed indicator signal with the insertion of a motion interference device if such a device is part of the safety guard system.

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The novel inventions provide general methodologies and processes for testing zero speed indicators by taking advantage of the physical fact that every moving machine element has a "speed rundown phase" when it is required to stop for whatever reason. Each rundown phase, whether it is forced to occur for test purposes as described herein, provides the opportunity to test the zero speed indicator attached to such an element for accuracy and reliability, giving in turn the opportunity to make the correct decision regarding the unlocking of the safety guards.

The various novel inventions disclosed herein were described in detail in the SUMMARY OF THE INVENTION SECTION. Since these novel inventions represent general methodologies and processes applicable to machine systems with zero speed indicators, their mechanical embodiments are illustrated here by way of examples only, using schematic deptictions of machine systems with zero speed indicators and testing arrangements. These are shown in Figs. 2,3,5 and 7. The corresponding processes, executing the testing and decision making for such test arrangements, are illustrated by means of general testing process and decision making flow diagrams shown in Figures 4A and 4B, 6A and 6B, 10, 11A-1 and 11A-2 and 11B-1 and 11B-2. Finally, figure 1 depicts a schematic view of a machine control arrangement including a safety guard control setup and a zero speed indicator testing system, applicable to machine systems such as those illustrated by Figures 2,3, 5 and 7 which would utilize the test process and decision flows of Figures 4A and 4B, 6A and 6B, 10, 11A-1 and 11A-2, 11B-1 and 11B-2.

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speed detector 42. During this phase, the detector 42 is monitored by a test device, means or method shown schematically as 48 to establish if the detector correctly determines and indicates zero speed. The tester 48 can employ any suitable verification device or method, including that recommended by the detector manufacturer. At the completion of the test, the detector 42 is recoupled to the saw arbor shaft 38 by the clutch/brake unit 40 to continue monitoring the speed status of the saw 36.

The test execution process for the mechanical embodiment of Figure 3 and the decisions on the test outcomes are all illustrated in detail in the flow chart diagram of Figure 4.

Figure 4 described below is a flow diagram subroutine detailing the test execution process and decisions on test outcomes for testing the integrity and accuracy of zero speed indicators in mechanical systems of running machines in general, in which the test is performed while the machine is running and without stopping the machine, as is embodied in the present novel invention. As such, this flow diagram is also applicable to the example mechanical systems presented in Figures 2 and 3.

The subroutine of Figures 4A and 4B is designated by the number 50 and is started by selecting a zero speed indicator to be tested at which time the test states are reset to start the test at 50A. At 50B the "zero speed indicator test on" informing devices are activated and at 50C there is applied a suitable testing device and/or method to the zero speed indicator's run down component is to be uncoupled from the monitored machine component to initiate its speed run down without stopping the machine component or the machine. At 50E there will be an indication of whether the zero speed indicator did or did not uncouple. If the indicator did not uncouple, it is a testing failure and thus the indicator cannot be tested. This will be recorded at 50 F. Following this at

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In Figure 5, the motor 52 drives the pulley system 53 which in turn rotates the flywheel 54. The flywheel is connected to a clutch and brake unit 56 through which the crankshaft 57 and associated connecting rod 58 is driven to reciprocate the ram 60. In this system is shown a zero speed indicator 62 us used to determine when a protective guard (not shown) can be unlocked to allow safe operator access to the dangerous space of the ram 60 and die 66 operation.

Any time the machine is declutched and braked to a stop at 56 due to an intermittent operation requirement of the ram 60, there is an opportunity to test in situ the reliability and accuracy of the zero speed indicator 62 by the schematically illustrated tester 68 during the speed run down phase of the stop without interruption of production. The tester 68 can be any suitable verification device or method including that recommended by the indicator manufacturer. Furthermore, whenever the press is shut down by control stops, emergency stops or power disconnects, there is the same opportunity to check or test in situ the reliability and accuracy of the zero speed indicator 62. Unlike the testing of the zero speed indicators during running of a machine as illustrated in Figures 2,3 and 4, the present testing, Figure 5, being done during stop initiations requires no special means for uncoupling the zero speed indicator from its driving machine component.

If the indicator fails the test then the decision can be made not to permit the unlocking of the protective guard until a scheduled repair/replacement and retest have been performed. These and other decisions on the test outcomes as well as the test execution process for the mechanical embodiment of Figure 5 are all illustrated in detail in the flow chart diagram of Figure 6.

Figures 6A and 6B described below is a flow diagram subroutine detailing the test execution process and decisions on test outcomes for testing the integrity and accuracy of zero speed indicators in

faulty devices will be scheduled after which there is a return at 92F to the subroutines main routine of Fig. 11.

It is to be noted that for the ultimate guard closure system the necessary conditions for unlatching the guard closure must include the following results: a) tests of the guard closure locks have been passed; b) tests on guard closures by force/displacement devices have been passed; c) tests on interlocks have been passed; d) tests on zero speed indicators have been passed; e) zero speed systems gives permission to unlatch the closure locks; f) tests on timers or delay devices have been passed; g) tests on interference systems have been passed and; j) machine power has been interrupted by control stop signals, emergency stop devices, or by power disconnects. Insofar as the details for accomplishing a), b) and c) are concerned reference is again made to the two applications 08/861,328 and 09/033,332 relating to such testing systems previously referred to.

We now turn to Figures 11A-1, 11A-2, and 11B-1, 11B-2 where there is an example of a main routine for testing safeguarding devices and systems for guard closures which directs and executes the use of the process and decision subroutines, Figures 4A and 4B, 6A and 6B, 9 and 10 previously described. This system is designated as 94 and begins with the machine system control unit at 94A. At 94B it will be determined if the main disconnect which is to be closed or opened at 94C has been closed. If the main disconnect has not been closed the machine is stopped at 94D and at 94E after the machine motion has stopped the guards will be unlocked if required and permitted. Following this the routine will be ended at 94F. If the main disconnect is closed then 94G will indicate if the control is or is not in the start position if preceding this the start/stop control has been activated at 94H. If the control is not in the start position then as indicated at 941 the machine is stopped and

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the system returns to 94F. If the control is in the start position at 94G then the emergency stop controls are checked if they are activated at 94J. Here again, emergency or other stop controls are activated or deactivated at 94K. If the stop controls are activated the machine will be stopped at 94L. AFter the machine motion has stopped the guards will be unlocked if required and permitted at 94M.

If the stop controls are not activated then 94N will indicate whether input/output controls are enabled. If the input/output controls are not enabled then 94P will enable the machine input/output. If they are enabled then at 94Q it will be indicated if the machine controls other then for interlocks/locks are satisfied at 94Q the state of the interlock/locks sensors determination is done at 94T. If the sensors states are satisfied then at 94V it is determined if the interlock/lock bypass was enabled by its test subroutine. If the interlock/lock bypass is not enabled the machine will be stopped at 94S. If the interlock/lock bypass is enabled then at 94W it will be ascertained if the interlock/locks and or guard closure testing is in progress. If the testing is in progress the system returns to the machine system control unit at 94A. If the interlock/locks and/or guard closure testing is not in progress it will be determined if the machine is running at 94X. If the machine is running 94Y (Figure 11B-1) will determine whether to initiate a machine component stop or not, or whether the machine is to be shut down or not. If the component is to be stopped or the machine is to be shut down then at 94Z (Fig. 11B-1) it will be decided whether to initiate and conduct tests of safeguarding devices and safeguarding systems for guard closures and/or for insertion of motion interference devices as a precursor to the stop/shut down. If it is not desired to initiate and to conduct tests then the system returns to the control unit at 94AA. However, if tests are to be conducted then the corresponding

conduct such tests there will be a return to the control unit at 94Q. If tests are to be conducted a guard closure to be tested is selected along with the corresponding test subroutines at 94RR. Following this there are in parallel with returning to the control unit at 94TT two choices available; 1) conduct interlock/lock and/or guard closure test per required test subroutine at 94SS or 2) conduct zero speed indicator tests per test subroutine of Figure 4 at 94UU. At 94 VV there will be a determination if the machine has been shut down by any subroutine due to fault detection. If it has been shut down the machine will be stopped at 94WW or if not the system will be returned to the control unit at 94XX. If the machine is stopped the necessary repair and/or replacement elements to enable restart of the machine will take place at 94YY following which the system returns to 94F (See Figure 11A-2), which completes the tasks of the main routine 94.

It remains to note that if the machine is not running at 94X then the guard closures will be closed and locked for machine start-up at 94ZZ and it will be determined at 95 whether or not the machine is to be started, If at 95 the machine is to be started, then at 95A it is checked if the machine is running or not. If not running, the system returns to 94S which completes the tasks of the main routine 94. If at 95A the answer is yes the machine is running, then the system goes to 94Y (Figure 11B-2). If at 95 it is decided not to start the machine then the system goes to 94S, the end of the tasks of the main routine.

It is intended to cover by the appended claims all such embodiments that come within the true spirit and scope of the invention.